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REINFORCED INORGANIC MOLDED PRODUCTS

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This invention relates to the manufacture of substantially inorganic molded products and it relates more particularly to the composition of a dry inorganic molding compound having glass fibers therein for reinforcement and strength and to products produced therefrom.

There has been a need for a molding material compounded chiefly of inorganic substances for use in the manufacture of molded products having the characteristics of high temperature resistance, fireproofness and relative inertness so as to provide a molded product capable of use within a temperature range and under conditions not available to the present organic compounds. Inorganic compounds having been produced but in most instances such materials have had relatively little flow and were therefore incapable of molding into intricate shapes and products molded therefrom were characterized by relatively low strength properties.

It is an object of this invention to produce an inorganic composition capable of molding under heat and pressure into a high strength product which conforms to mold shape, and it is a related object to produce a molded product of the type described having fibrous reinforcement to impart markedly improved strength properties.

Another object of this invention is to produce and to provide a method for producing molded products of inorganic materials and it is a related object to produce a product of the type described embodying glass fibers for reinforcement and strength.

A further object is to produce a dry composition formed chiefly of inorganic materials for molding into products having high strength, weather and water resistance and resistance to atmospheric attack and which can be used as a structural material where high temperature resistance and flameproofness constitute some of the requirements.

Broadly defined, the concepts of this invention are embodied in a molding composition containing a hydrated inorganic salt which, under heat and pressure, releases water of crystallization sufficient to dissolve or form a slurry of the salt whereby the composition becomes capable of flow sufficient for molding. Solidification to mold shape may occur from loss of water and cooling down to room conditions but it is preferred to embody herein a metallic oxide or hydroxide which, under conditions of molding, combine with the salt to form a reaction product capable of retaining mold form.

More specifically, invention herein resides in a dry molding compound formulated of glass fibers of relatively short lengths in admixture with magnesium oxide or magnesium hydroxide and a hydrated magnesium sulphate, such as magnesium heptahydrate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) which, under heat and pressure, liberates water of hydration in amounts sufficient to produce plastic flow to the composition sufficient to fill the mold and for simultaneous reaction, in whole or in part, to a magnesium oxysulphate type cement. The consolidated product retains mold form and is strengthened beyond expectation by the glass fibers integrated therewith.

The ratio of oxide to sulphate may be varied over a relatively wide range. Calculated on the basis of molecular equivalents, it is preferred to combine one mol of a hydrated inorganic metallic salt with 2-3 mols of the metallic oxide or hydroxide depending on the amount of water of hydration present in the salt and the availability thereof. Satisfactory molding compositions have

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been produced with the materials being present in the ratio of one mol of the salt to one mol of the oxide or hydroxide ranging down to one mol of the hydrated salt to 9 mols of the oxide or hydroxide. When the hydrated metal salt comprises magnesium sulphate heptahydrate or the like, it is preferred to make use of 3 mols of the magnesium oxide (33 parts by weight) to one mol of the magnesium sulphate heptahydrate (67 parts by weight) but the range may extend from equal molecular equivalents of the oxide and heptahydrate (14 parts MgO to 86 parts $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) to 9 molecular equivalents of magnesium oxide to one molecular equivalent of magnesium sulphate heptahydrate (60 parts MgO to 40 parts $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$).

Magnesium oxide suitable in the practice of this invention is selected of brucite manufactured by the Dow Chemical Company from the Luddington, Michigan brine or Sierra magnesite manufactured by the Schundler Company. It will be understood that other magnesium oxides derived from other sources can also be used. Introduction of the magnesium oxide is generally made in powder form and admixed with the magnesium sulphate heptahydrate which is reduced to particle sizes from 40-60 mesh or the like. In the event that the hydrated salt becomes sticky by the heat developed in grinding, it is advisable to introduce the magnesium oxide in powder form in advance thereof.

In the absence of substantial amounts of resinous material or the addition of water, which materials might be capable of imparting flow to the molding compound, a dry compound capable of flow sufficient to fill the mold form under heat and pressure cannot readily be compounded with reinforcement or filler of the type such as wood flour, cellulose fiber, asbestos fiber or other absorbent reinforcing fibers. Without reinforcement, the product molded of the dry inorganic materials is relatively weak and, in many instances, unfit for the purpose for which it was intended. It has been found that reinforcement as to strength can be effected by way of incorporation of glass fibers within certain amounts. The glass fibers do not appear materially to inhibit the moldability of the compound but they seem to tie into the compound in a manner markedly to increase the strength of the molded product. With the addition of 4-6 percent by weight glass fibers, it has been found that the strength of the molded product may be increased as much as five-fold. Thus it has been possible by the incorporation of glass fibers with binder formed of magnesium oxide and hydrated magnesium sulphate to compound a product capable of molding by conventional means into a high strength product which retains the desirable characteristics of an organic system.

Glass fibers for reinforcement are preferably selected of strands formed of 100 or more continuous glass filaments arranged in a compact bundle, or a plurality of such strands twisted or intertwisted together, and cut or chopped to shorter lengths ranging from $\frac{1}{8}$ -2 inches. Instead, the glass fiber component may be formed of staple fibers which are fibers that are discontinuous in character and attenuated from molten glass streams by a blowing or drawing operation. Such discontinuous fibers may be cut to shorter lengths or a plurality of such fibers may be felted together and then drafted into yarns of substantial lengths which may be cut or chopped to desired shorter lengths for incorporation as an ingredient in the molding composition.

Although it is preferred to make use of glass fiber in amounts ranging from 2-7 percent by weight, it is possible to incorporate up to 10-12 percent depending upon the moisture which can be made available from the hydrated salt under molding conditions.

Certain modifications can be made in the molding composition by introduction of small amounts of pigment to impart color or by the addition of natural oils, synthetic oils, waxes, gums and metal soaps to improve the finish, increase the strength and waterproofness of the final product. Ordinarily such additions should not be made in amounts greater than 2 percent by weight and when more than one modifying ingredient is introduced, the total should not exceed 5 percent of the final product.

In practice, the magnesium sulphate heptahydrate is